

CLAIMS

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61 1. An image processing apparatus comprising:  
gradient calculation means for calculating at least the  
direction of the level gradient of a processing unit in  
5 given image data including a plurality of pixels, the pixels  
respectively having level data;

line segment formation means for producing line segment  
image data representing a line segment having a direction  
corresponding to the direction of the level gradient which  
10 is calculated by said gradient calculation means and a given  
length; and

line segment image storage means for storing the line  
segment image data produced by said line segment formation  
means.

25 2. The image processing apparatus according to claim 1,  
further comprising

image storage means for storing said given image data.

A 3. The image processing apparatus according to claim 1 or  
A 2, further comprising

20 image data extraction means for extracting image data  
in a processing region set in input image data and feeding  
the extracted image data to said gradient calculation means.

4. The image processing apparatus according to claim 3,  
further comprising

25 means for setting said processing region.

A 5. The image processing apparatus according to <sup>claim 1</sup> ~~any one of~~  
A ~~claims 1 to 4~~, wherein

said line segment formation means produces line segment image data at a gray level.

A 6. The image processing apparatus according to <sup>claim 1</sup> ~~any one of~~  
A ~~claims 1 to 4~~, wherein

5 said line segment formation means produces line segment image data at a binary level.

A 7. The image processing apparatus according to <sup>claim 1</sup> ~~any one of~~  
A ~~claims 1 to 6~~, wherein

said gradient calculation means calculates the  
10 magnitude of the level gradient in addition to the direction of the level gradient.

A 8. The image processing apparatus according to <sup>claim 1</sup> ~~any one of~~  
A ~~claims 1 to 5~~, wherein

said gradient calculation means calculates the  
15 magnitude of the level gradient in addition to the direction of the level gradient, and

said line segment formation means produces line segment image data having a level corresponding to the magnitude of the level gradient which is calculated by said gradient  
20 calculation means.

A 9. The image processing apparatus according to <sup>claim 1</sup> ~~any one of~~  
A ~~claims 1 to 6~~, wherein

said gradient calculation means calculates the  
25 magnitude of the level gradient in addition to the direction of the level gradient, and

said line segment formation means produces line segment image data only when the magnitude of the level gradient

which is calculated by said gradient calculation means is not less than a predetermined threshold.

A 10. The image processing apparatus according to <sup>claim 1</sup> ~~any one of~~ <sup>^</sup> ~~claims 1 to 9~~, wherein

5 said line segment image storage means adds new line segment image data to line segment image data already stored at each of the pixels, and stores the result of the addition.

A 11. The image processing apparatus according to <sup>claim 1</sup> ~~any one of~~ <sup>^</sup> ~~claims 1 to 9~~, wherein

10 said line segment image storage means stores new line segment image data without subjecting the line segment image data to addition processing.

A 12. The image processing apparatus according to <sup>claim 1</sup> ~~any one of~~ <sup>^</sup> ~~claims 1 to 11~~, wherein

15 said line segment formation means produces a line segment having a predetermined length in a direction corresponding to the calculated direction of the level gradient from the position of the processing unit.

20 A 13. The image processing apparatus according to <sup>claim 1</sup> ~~any one of~~ <sup>^</sup> ~~claims 1 to 11~~, wherein

25 said line segment formation means produces, when the distance from the position of the processing unit to an initial point and the distance from the processing unit to a terminal point are given, a line segment from said initial point to said terminal point in a direction corresponding to the calculated direction of the level gradient.

14. The image processing apparatus according to claim 12,  
further comprising

means for setting the length of the line segment.

15. The image processing apparatus according to claim 13,  
5 further comprising

means for setting at least one of the distance from the  
processing unit to the initial point and the distance from  
the processing unit to the terminal point.

A 16. The image processing apparatus according to <sup>claim 1</sup> ~~any one of~~  
10 ~~claims 1 to 15~~, further comprising

means for detecting a portion where line segments  
represented by the line segment image data stored in said  
line segment image storage means are concentrated.

A 17. The image processing apparatus according to <sup>claim 1</sup> ~~any one of~~  
15 ~~claims 1 to 15~~, further comprising

means for detecting the position of the pixel having  
the maximum of the levels of the line segment image data  
stored in said line segment image storage means.

18. The image processing apparatus according to claim 17,  
20 further comprising

means for judging whether or not said maximum level  
exceeds a predetermined threshold.

A 19. The image processing apparatus according to <sup>claim 1</sup> ~~any one of~~  
A ~~claims 1 to 18~~, further comprising

25 image input means having a camera for producing image  
data and feeding the produced image data to said gradient  
calculation means.

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A 20. The image processing apparatus according to <sup>claim 1</sup> ~~any one of~~  
A ~~claims 1 to 15 and claim 19~~, further comprising

a display device for displaying a line segment image  
represented by the line segment image data produced by said  
5 line segment formation means or the line segment image data  
stored in said line segment image storage means.

21. The image processing apparatus according to claim 20,  
wherein

10 said display device displays an image represented by  
said given image data with the image overlapped with said  
line segment image.

22. The image processing apparatus according to claim 20,  
further comprising

15 means for extracting an edge of the image represented  
by said given image data,

said display device displaying an image represented by  
the extracted edge with the image overlapped with said line  
segment image.

20 23. The image processing apparatus according to claim 16,  
further comprising

a display device for displaying a mark representing the  
portion, where the line segments are concentrated, detected  
by said detection means with the mark overlapped with the  
image represented by said image data.

25 24. The image processing apparatus according to claim 17,  
further comprising

a display device for displaying, at the position of the

pixel having the maximum level which is detected by said detection means, a mark indicating that the pixel has the maximum level with the mark overlapped with the image represented by said image data.

5 25. The image processing apparatus according to claim 18, further comprising

a display device for displaying, at the position of a pixel having the maximum level which is judged to exceed a threshold by said judgment means, a mark indicating that the  
10 pixel has the maximum level with the mark overlapped with the image represented by said image data.

A 26. The image processing apparatus according to <sup>claim 23</sup> ~~any one of~~  
A ~~claims 23 to 25~~, further comprising

means for extracting an edge of the image represented  
15 by said image data,

said display device displaying an image represented by the edge extracted by said edge extraction means in addition to or in place of the image represented by said image data.

20 27. The image processing apparatus according to claim 26, wherein

said display device displays the line segment image represented by said line segment image data with the line segment image further overlapped with the image represented by the edge.

25 28. An image processing apparatus comprising:

*28m* image processing means for calculating at least the direction of the level gradient of a processing unit in

given image data, and producing line segment image data representing a line segment having a direction corresponding to the calculated direction of the level gradient; and

display means for displaying a line segment image  
5 represented by the line segment image data produced by said image processing means.

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29. The image processing apparatus according to claim 28, wherein

10 said display device displays the image represented by said image data with the image overlapped with said line segment image.

30. The image processing apparatus according to claim 29, further comprising

15 means for extracting an edge of the image represented by said image data,

said display device displaying an image represented by the edge extracted by said edge extraction means in addition to or in place of the image represented by said image data.

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31. An image processing method comprising the steps of:

calculating at least the direction of the level gradient of a processing unit in given image data including a plurality of pixels, the pixels respectively having level data;

25 producing line segment image data representing a line segment having a direction corresponding to the calculated direction of the level gradient and a given length; and storing the produced line segment image data in storage

means.

32. A medium storing a program for controlling a computer so as to:

calculate at least the direction of the level gradient  
5 of a processing unit in given image data including a  
plurality of pixels, the pixels respectively having level  
data;

produce line segment image data representing a line  
segment having a direction corresponding to the calculated  
10 direction of the level gradient and a given length; and  
store the produced line segment image data in storage  
means.

33. An image processing method comprising:

calculating at least the direction of the level  
15 gradient of a processing unit in given image data, and  
producing line segment image data representing a line  
segment having a direction corresponding to the calculated  
direction of the level gradient; and

displaying a line segment image represented by the  
20 produced line segment image data on a display device.

34. A medium storing a program for controlling a computer so as to:

calculate at least the direction of the level gradient  
of a processing unit in given image data, and produce line  
25 segment image data representing a line segment having a  
direction corresponding to the calculated direction of the  
level gradient; and



display a line segment image represented by the  
produced line segment image data on a display device.

35. An image processing apparatus comprising:

5 means for extracting a plurality of edges whose level  
gradients are not less than a predetermined value in given  
image data;

means for setting, for each of the edges, a line  
segment extending in a direction corresponding to the  
direction of the extracted edge; and

10 means for detecting the presence or absence of a point  
of intersection of a plurality of line segments and the  
position thereof.

36. The image processing apparatus according to claim 35,  
wherein

15 the direction of the line segment is a direction  
perpendicular to the direction of the edge or the same  
direction as the direction of the edge.

37. An inspection apparatus comprising:

20 image input means for inputting image data representing  
an inspection object;

means for calculating at least the direction of the  
level gradient of a processing unit in said input image  
data, and producing line segment image data representing a  
line segment having a direction corresponding to the  
25 calculated direction of the level gradient; and

means for detecting the presence or absence of a  
portion where line segment images are concentrated or are

overlapped with one another and the position thereof on the basis of the produced line segment image data.

38. The inspection apparatus according to claim 37, wherein

the direction corresponding to the direction of said level gradient is the direction of the level gradient or a direction perpendicular to the direction of the level gradient.

39. The inspection apparatus according to claim 38, further comprising

a display device for displaying the line segment image on the basis of said line segment image data.

40. The inspection apparatus according to claim 39, wherein

said display device displays an image of the object represented by said input image data with the image overlapped with the line segment image.

41. The inspection apparatus according to claim 37 or 38, further comprising

a display device for displaying the detected position of the portion where the line segment images are concentrated or are overlapped with one another on the image of the object represented by said input image data or an image represented by an edge extracted from said input image data.

42. The inspection apparatus according to <sup>claim 37</sup> ~~any one of claims~~

~~37 to 41~~, further comprising

means for inputting data relating to the length of the line segment or the initial point and the terminal point of

the line segment.

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